DECam Prototype Observations for Calibration of the Dark Energy Survey

DARK ENERGY SURVEY

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The Era of Observational Cosmology

Observations show that the cosmos is dominated by a mysterious "Dark Energy" that drives the accelerated expansion of the universe. The properties of Dark Energy can be expressed in terms of its Equation of State at different redshifts:

$w(z) = p/\rho$

We parameterize $w(z)$ as follows:

$w(z) = w_0 + w_a(1-a)$, where $a = (1+z)^{-1}$

The Dark Energy Survey (DES) will repeatedly observe 5000 deg^2 of the southern sky, significantly improving measurements of w_a and w_0 (see Fig. 1).
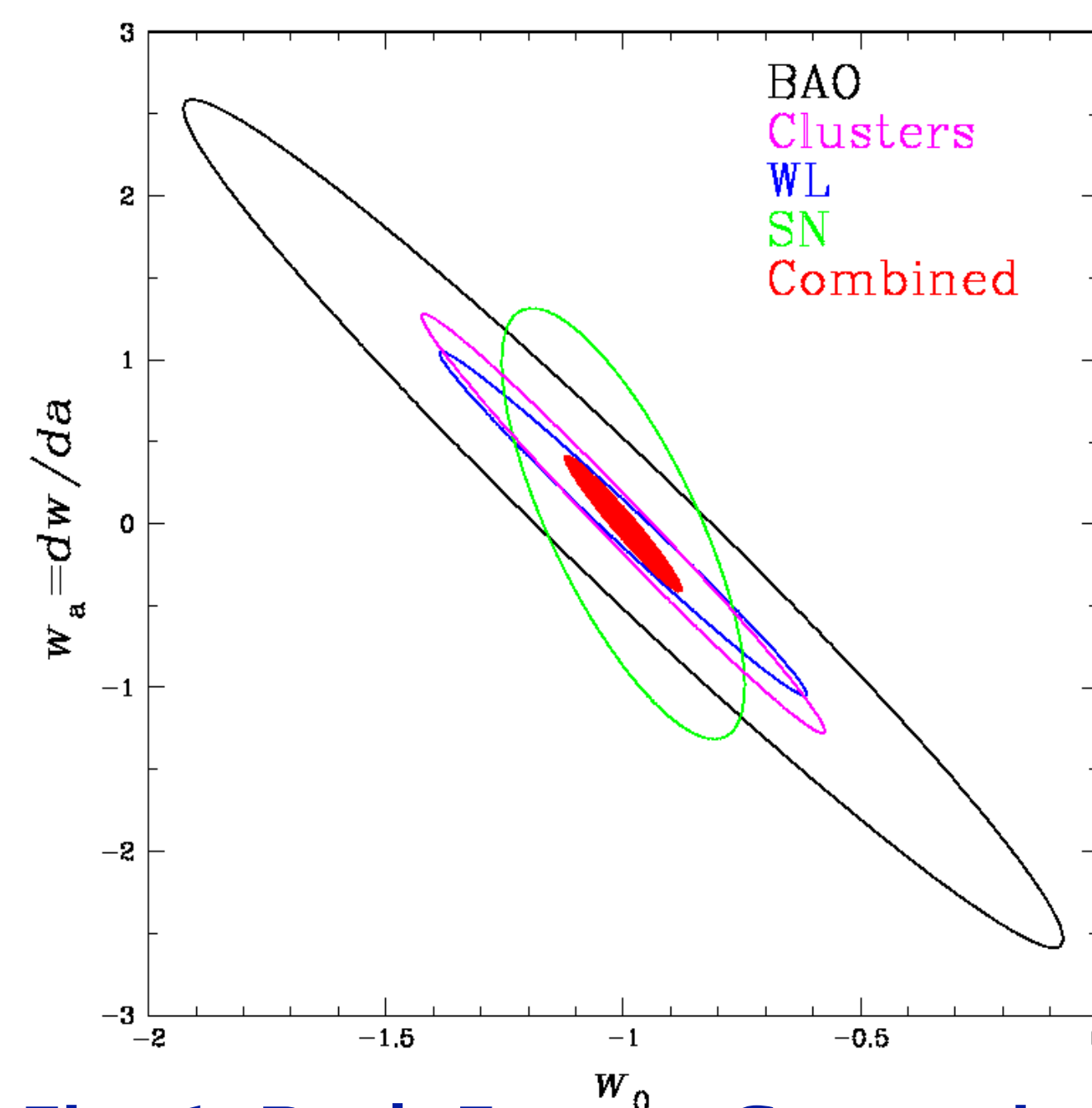

Fig. 1: Dark Energy Constraints

The Dark Energy Camera

The Dark Energy Camera (DECam), currently being assembled and tested at Fermilab, will be installed at the prime focus of the 4m. Blanco Telescope at Cerro Tololo Inter-American Observatory in Chile. DECam consist of 62 2k x 4k extremely red-sensitive (QE > 50% at 1000nm) CCDs, plus associated guide/focus CCDs, with a field of view of approximately 3 square degrees.

Figure 2: The Dark Energy Camera being tested at Fermilab

PreCam: The Dark Energy Survey Precursor Camera

PreCam consists of two 2k x 4k CCDs identical to those used in the Dark Energy Survey, along with a pressure control system, cryogenics, and other hardware functionally similar to DES. PreCam also incorporates scaled-down version of DES filters, readout electronics, and software infrastructure for instrument control and telemetry feedback.

PreCam observations were scheduled for 100 nights on the Curtis-Schmidt (University of Michigan) telescope at Cerro Tololo, starting in August 2010 and ending in January 2011.
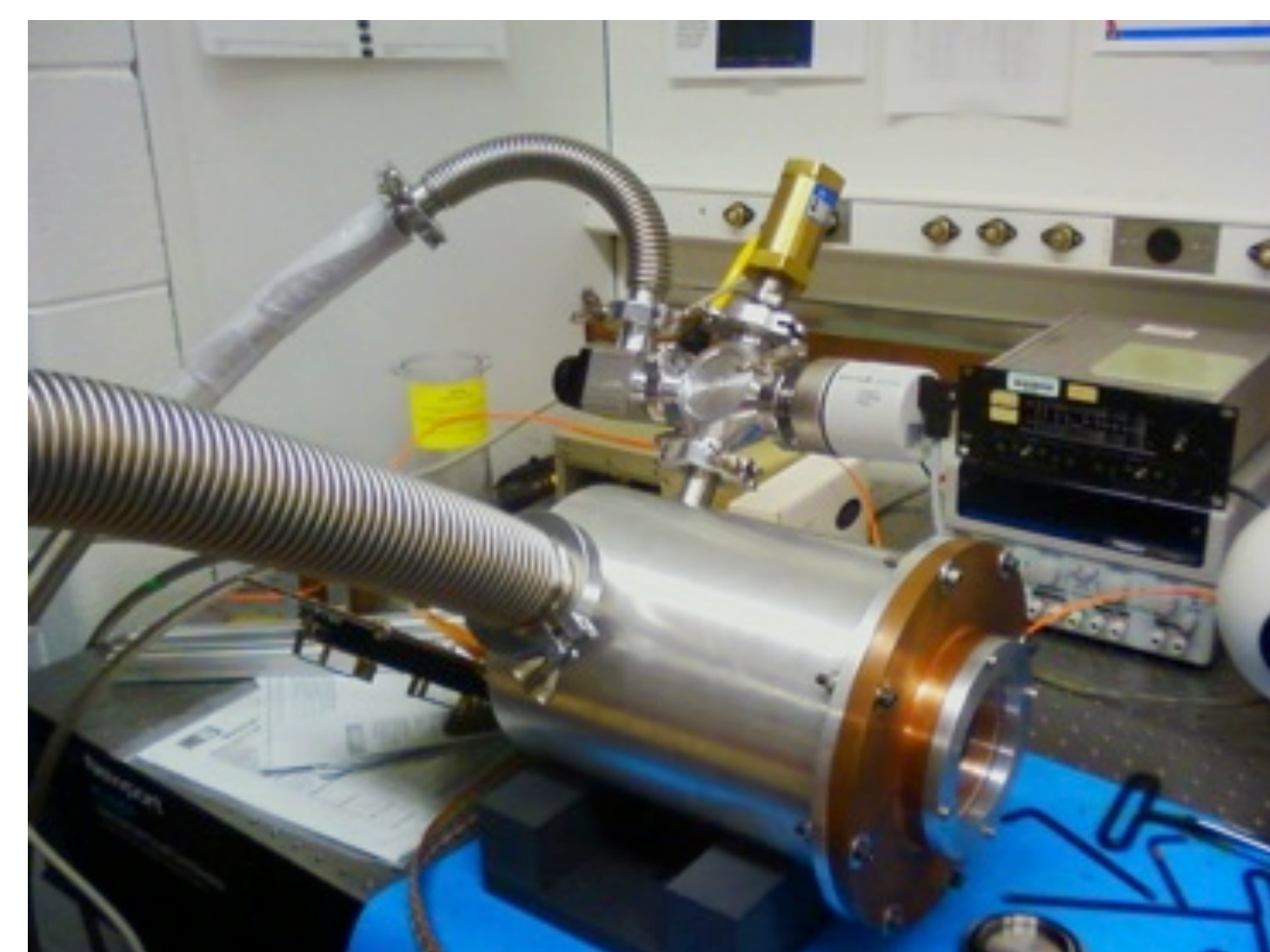

Figure 3: PreCam on its test stand at Argonne National Lab

Calibration of the Dark Energy Survey with PreCam

PreCam's observation strategy is expected to save DES up to 10% of its survey time by providing calibration data for hundreds of stars per square degree in a sparse grid across the DES footprint. Calibration data include extinction standards and nightly photometric solutions which will contribute to improving DES global relative calibrations from its 2% requirement to its 1% goal. It will also contribute to SDSS-DES Transformations based on numerous observations of Stripe 82, and it will provide important new data on Southern Hemisphere Y-band standard stars. Finally, PreCam will provide a bright star catalog for subsequent DES Image Quality tests as well as science data for bright objects in the DES footprint such as Milky Way red giants or local supernova.

Current Status of PreCam

As of 2011-01-10, PreCam had successfully completed a significant fraction of its proposed observations, as summarized in Tables 1 and 2 and Figure 4.

Tiling	g	r	i
1	255	255	255
2	247	196	191
3	274	257	197
4	249	235	252
5	174	34	172
6	64	37	115
7	36	34	36
8	43	39	6
9	69	43	43
10	159	153	153

Table 1: Completed g,r,i observations in the PreCam grid

Tiling	g	r	i	z	y
1	27	2	27	27	27
2	27	27	27	27	14
3	27	27	27	27	27
4	27	27	27	27	27
5	27	27	27	0	23
6	27	27	26	19	27
7	27	27	27	0	27
8	27	27	1	11	27
9	27	27	27	0	3
10	27	27	27	4	0

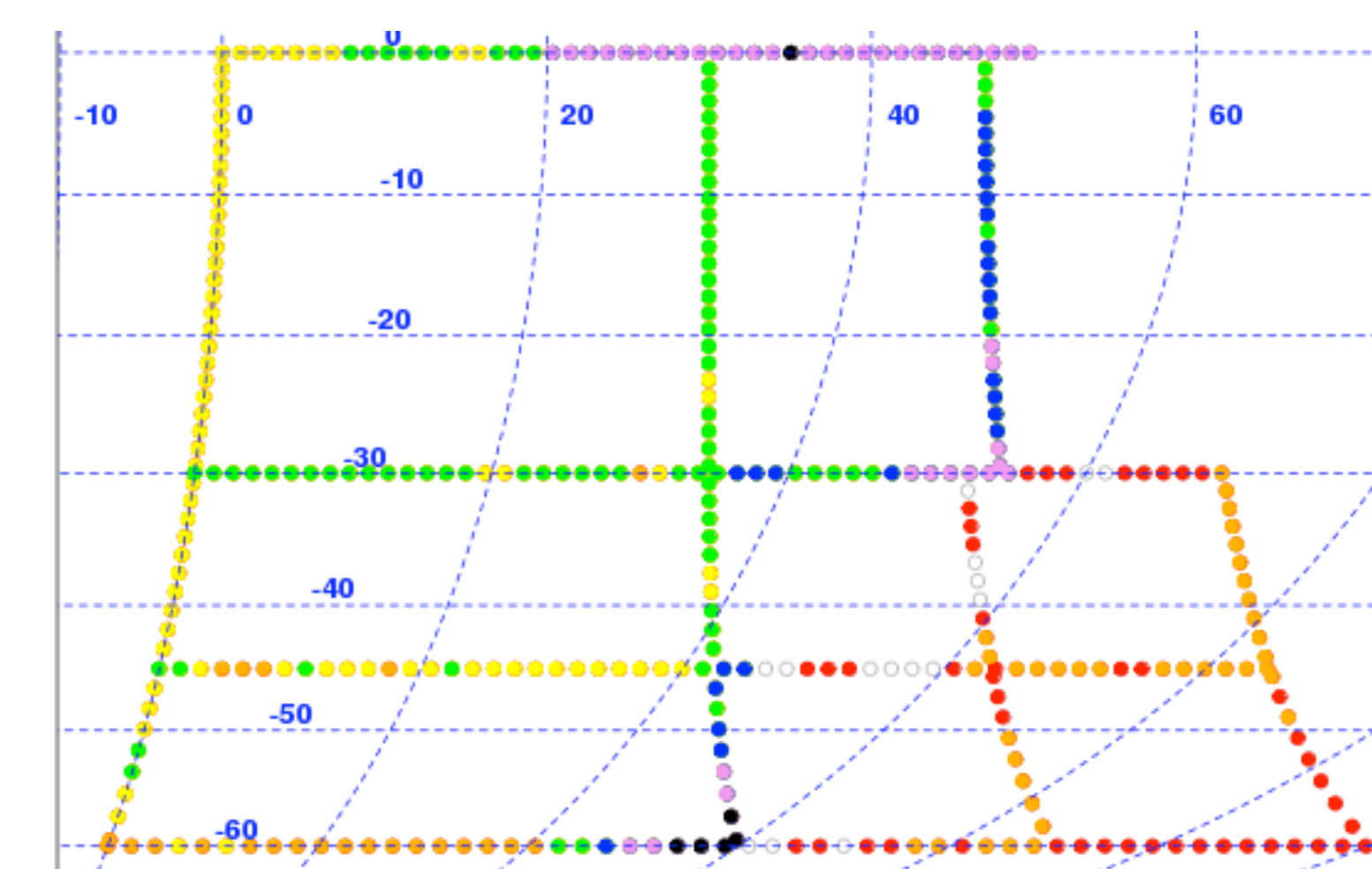**Table 2: Completed g,r,i,z,y observations in SDSS Stripe 82**

Figure 4: PreCam "Rib and Keel" pattern of completed observations

Conclusions

PreCam has made significant progress toward its primary goal of providing calibration data for the Dark Energy Survey. Important secondary goals have also been achieved, including testing of prototype DES hardware, software, and commissioning and observing procedures. We are currently exploring ways for PreCam to continue its mission in support of the Dark Energy Survey.

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